Proposal for a Joint NASA/KSAT Ka-band RF Propagation Terminal at Svalbard, Norway

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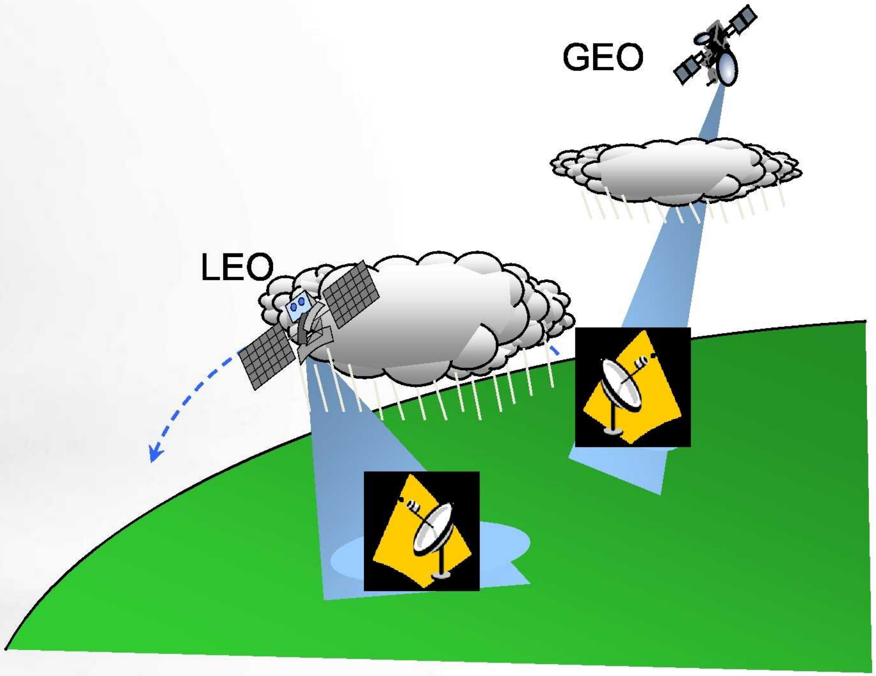
Keeping the universe connected.

Why are these studies important?

As science mission data throughput demands increase, it is desired by NASA to characterize the site-dependent atmospheric propagation effects at Ka-band frequencies to manage expectations for NEN system performance

Propagation Study Goals:

- Determine expected site-dependent low level signal attenuation at Ka-band for NEN sites
- Determine extent of increase in system noise temperature at Ka-band for NEN sites
- *Determine extent of high level signal attenuation , scintillations and depolarization effects at Ka-band for NEN sites (IF A SATELLITE OPPORTUNITY EXISTS)*



Benefits to NASA/KSAT

- Enhanced system planning through accurate determination of expected Ka-band attenuation and depolarization performance
- Improve mission planning to manage expectations/maximize mission success and data throughput
- Enhance fidelity of current ITU-R and global propagation models
- Augment current propagation databases with new data in an area of the world where no previous Ka-band propagation measurements currently exist
- Prepare for deployment of NEN Ka-band polar network

NASA Experience in RF Propagation Experiments

(See REFERENCES Section for List of Relevant Publications)

Ka-Band Rain Attenuation Measurements

1991 – 2004 : Collected 36 Station-Years

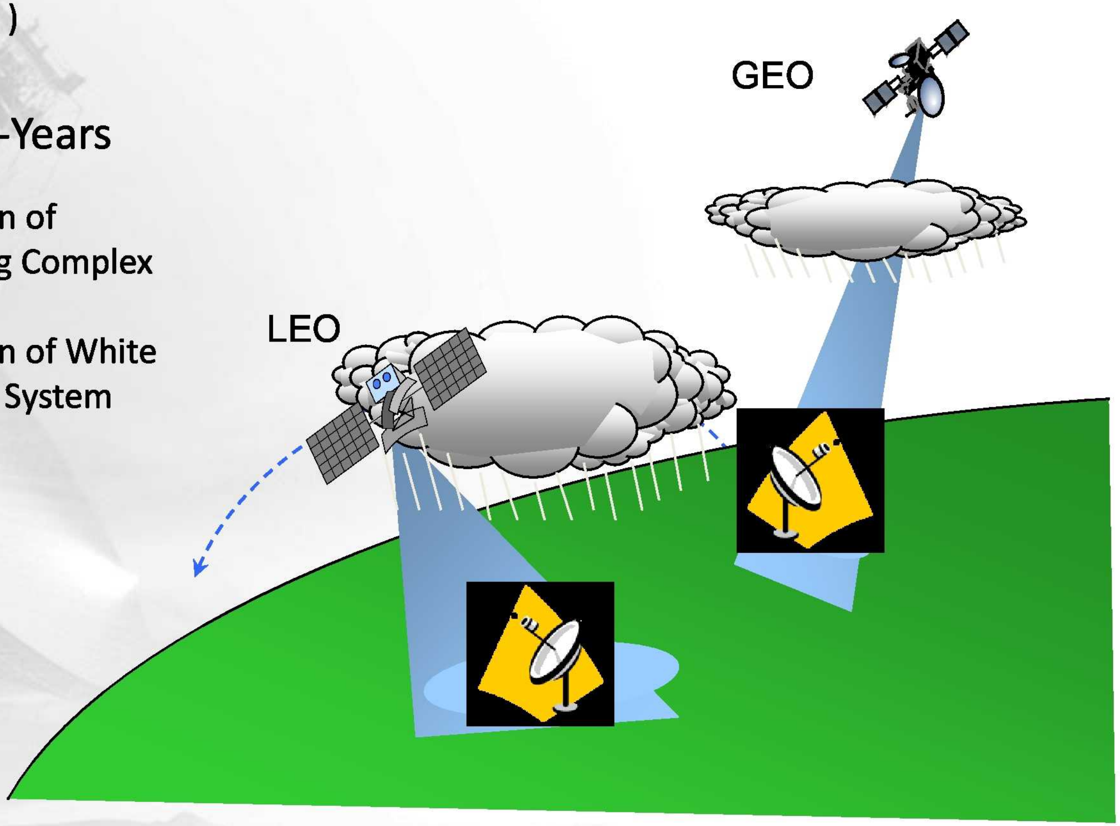
Advanced Communications Technology Satellite (ACTS)

Developed the Ka-Band ITU-R Attenuation Model
(not accurate on average of ~ 3 – 6 dB @ 90%)

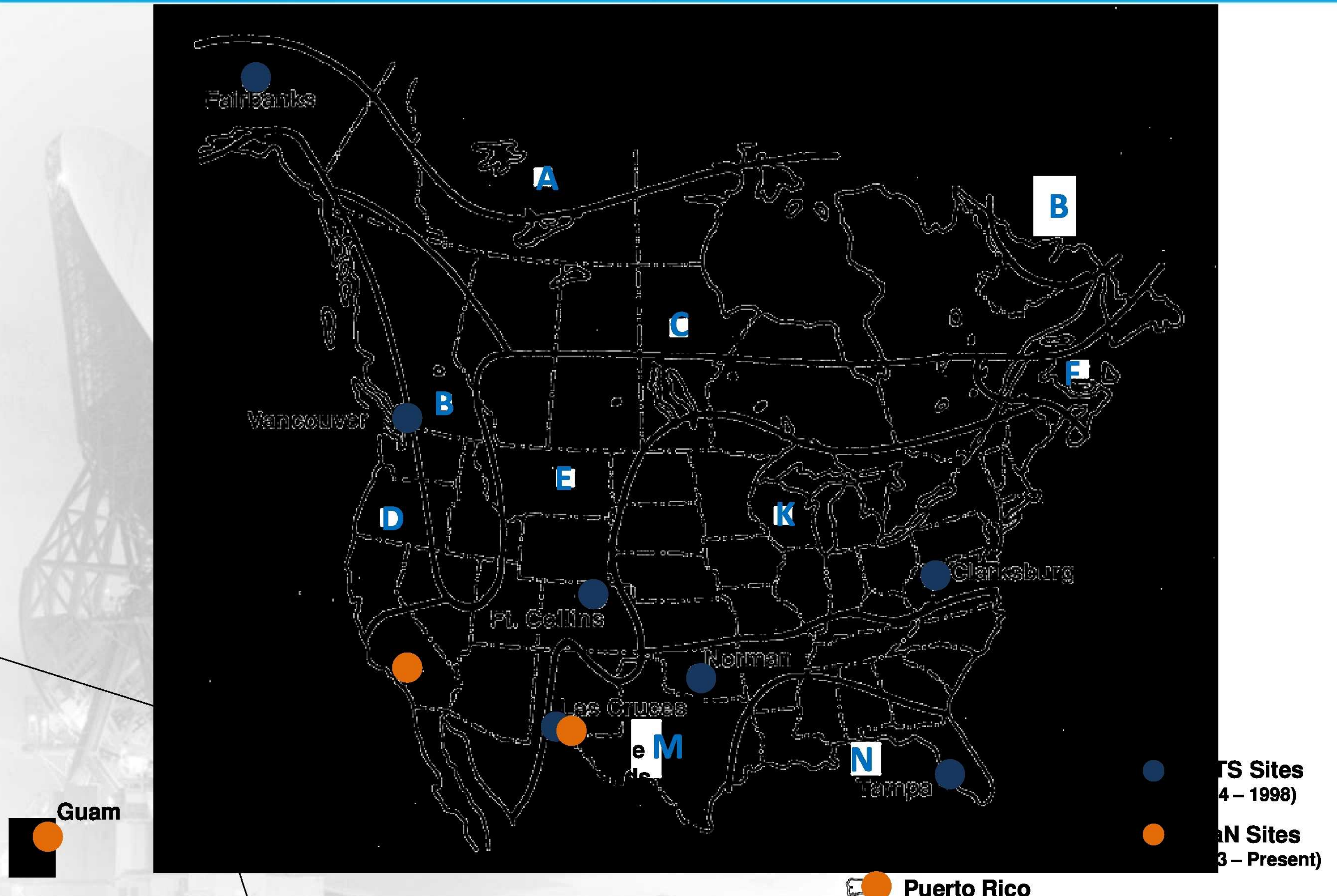
2007 – Present : Collected 5 Station-Years

Ka-Band Amplitude and Phase Characterization of Goldstone Deep Space Network (DSN) Tracking Complex

Ka-Band Amplitude and Phase Characterization of White Sands/Guam Tracking and Data Relay Satellite System (TDRSS) Ground Terminals



NASA Sites Characterized 1991 – 2010

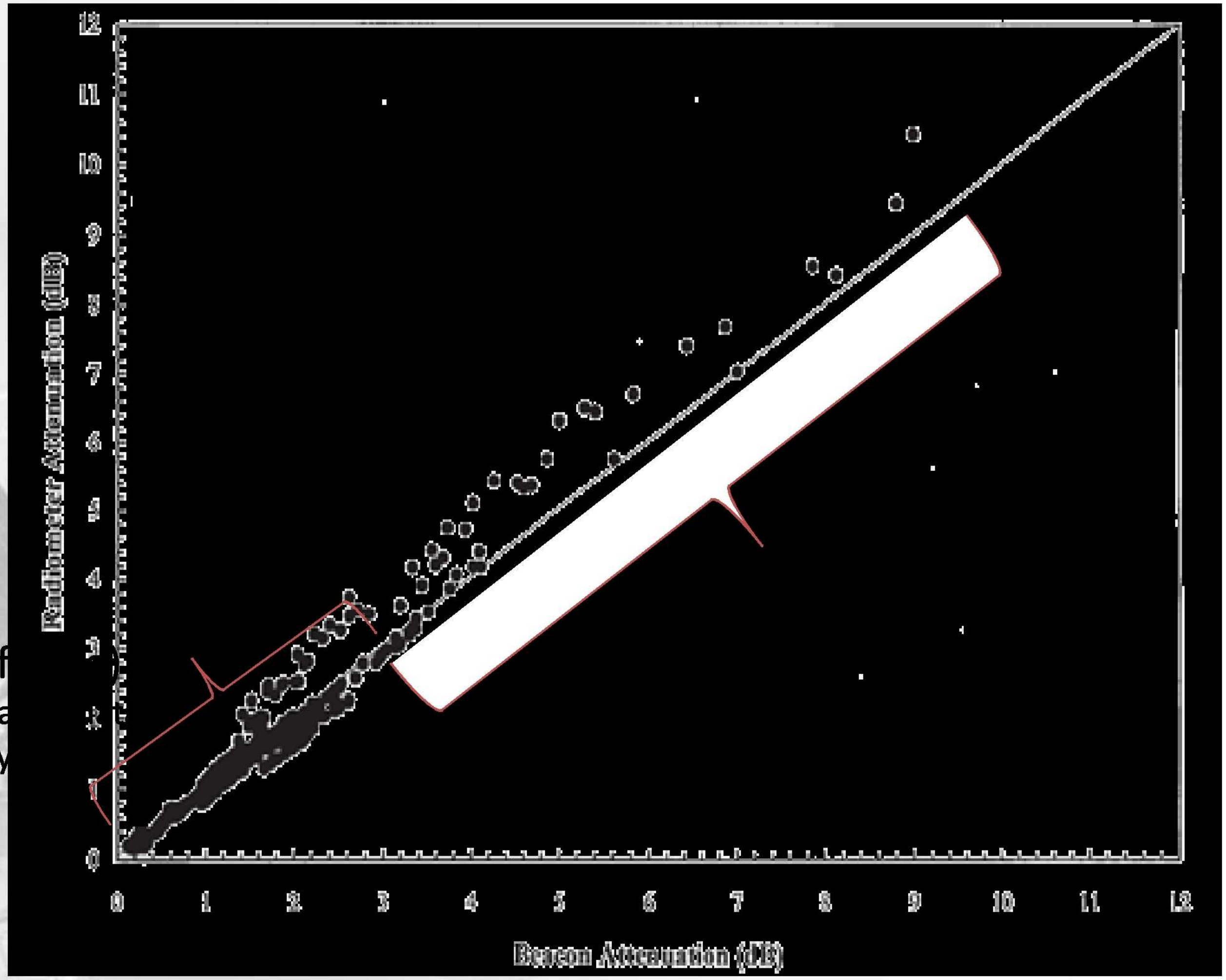


Lessons Learned From Site Characterization

Location	Frequency: Station Years	Lessons Learned
Fairbanks, Alaska ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Cloud Effects Scintillation
British Columbia, Canada ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Fade Duration Scintillation effects Melting layer
Fort Collins, Colorado ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Rain and snow effects Polarimetric radar
Tampa, Florida ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Subtropical Zone Site Diversity
Las Cruses, New Mexico TDRS GN	20.2 GHz : 6 st. yrs. 27.5 GHz : 5 st. yrs.	Scintillation TDRS ancillary data * Phase Decorrelation
Norman, Oklahoma ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Rain Rate Scintillation Snow on Antenna
Clarksburg, MD ACTS	20.2 GHz : 5 st. yrs. 27.5 GHz : 5 st. yrs.	Rain Rate Scintillation
Ashburn, VA SOMD	20.2 GHz : ~1 st. yr.	Depolarization
Humacao, Puerto Rico SOMD	20.7 GHz : 1.5 st. yrs.	Tropical Zone
Goldstone, California DSN GN	20.2 GHz : 3.5 st. yrs.	* Phase Decorrelation Cloud Effects Desert Zone

Similar Climate Measurements

(Example Analysis)



Alaska (90% of

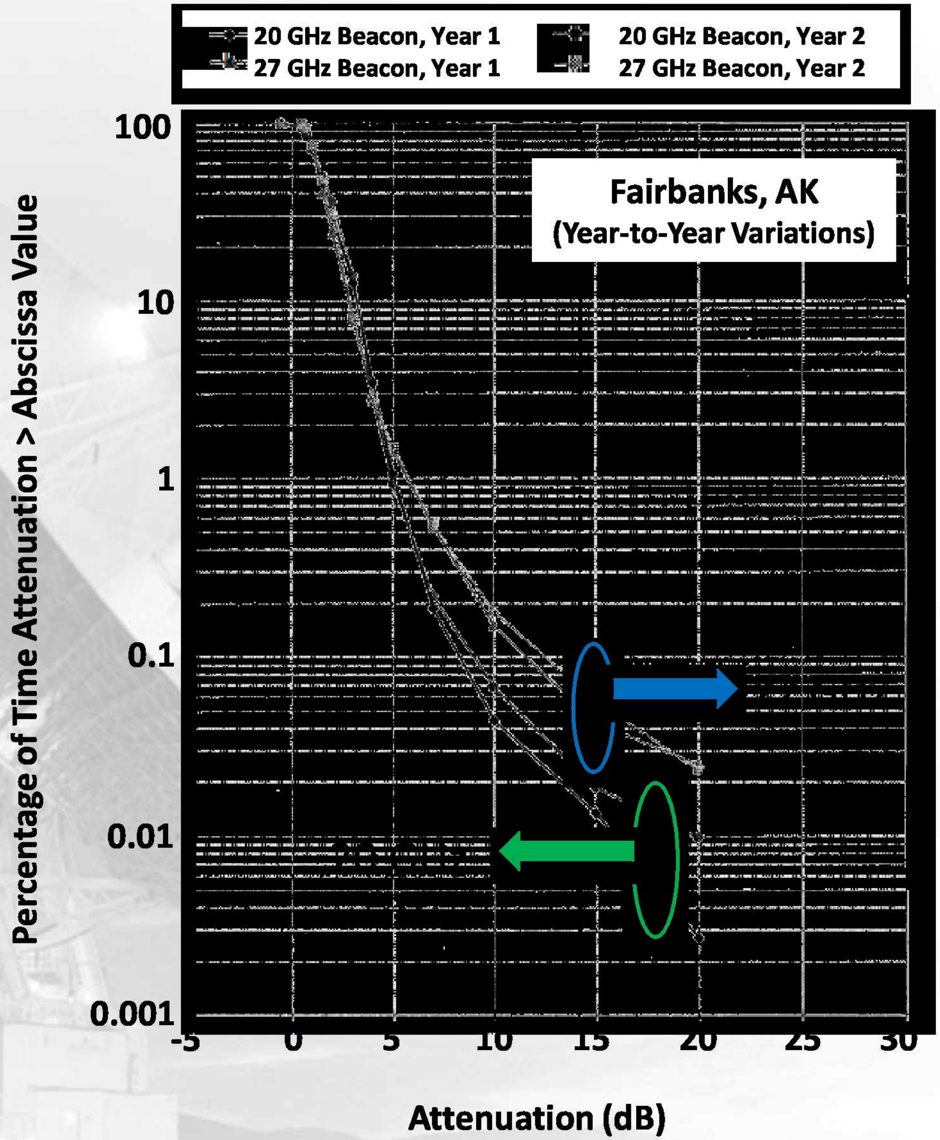
Radiometer and Bea

agree extremely

Note: Based on climatological similarities/differences with Alaska, Svalbard site *expected* to have good radiometer/beacon agreement ~99% of time (lower rain rate region)

Similar Climate Measurements

(Example Analysis)



Lessons Learned

1 – Design Links based on actual data (~ 5 years, but 3 is reasonable)

2 – 1 dB extra margin at 27 GHz vs. 20 GHz at > 99 % weather

Proposed NASA/KSAT Ka-Band Campaign

PRIMARY GOALS –

- Radiometric observations of sky brightness temperature at relevant frequency and elevation angle of operation to determine increase in system noise temperature and attenuation

SECONDARY GOALS –

- Measurements of atmospheric depolarization and scintillation effects if satellite of opportunity (possessing a K/Ka-band beacon) can be identified.
- Higher fidelity attenuation data (>99% availability level) utilizing beacon signal measurement

A Space Act agreement between NASA and KSAT would be required

- ± Each party brings to the table the funding and expertise and analyzed data is made available to KSAT

Expected financial costs from both NASA and KSAT

Proposed NASA/KSAT Ka-Band Campaign

NASA Responsibilities

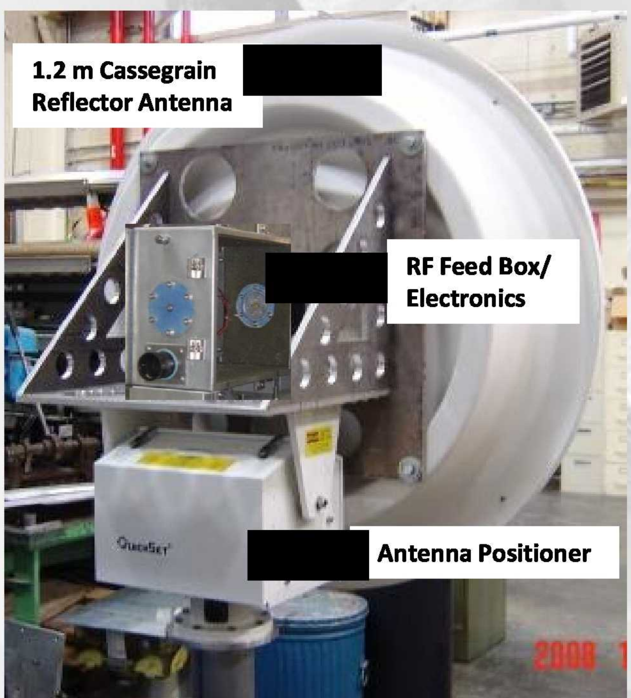
± Construction and system testing of RF Propagation Terminal

± Perform installation of propagation terminal and radome at Svalbard site

± Assist in system diagnostics and repair, if necessary

± Analysis of recorded data

NASA to provide the following hardware:



Proposed NASA/KSAT Ka-Band Campaign

KSAT Responsibilities

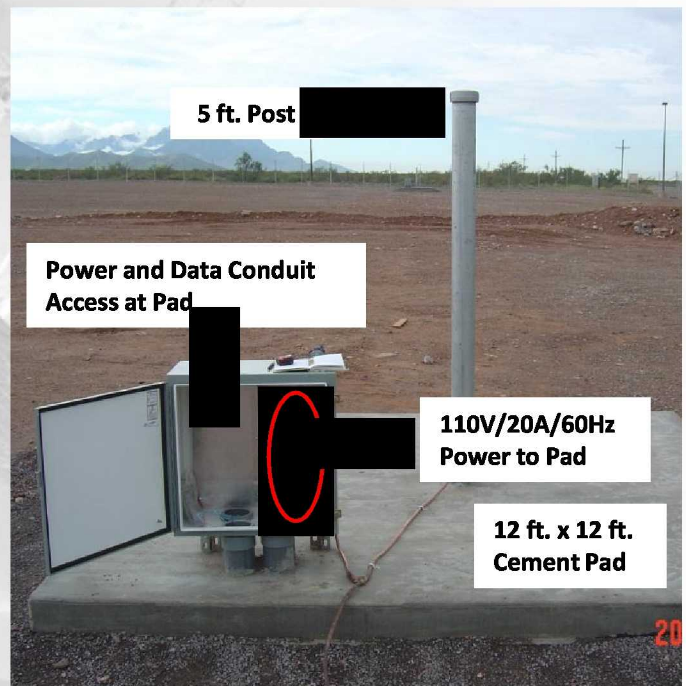
± Preparation of site (cement pads, **CABLE CONDUITS,** infrastructure, data transfer, etc.)

± Assist in propagation terminal installation at Svalbard site

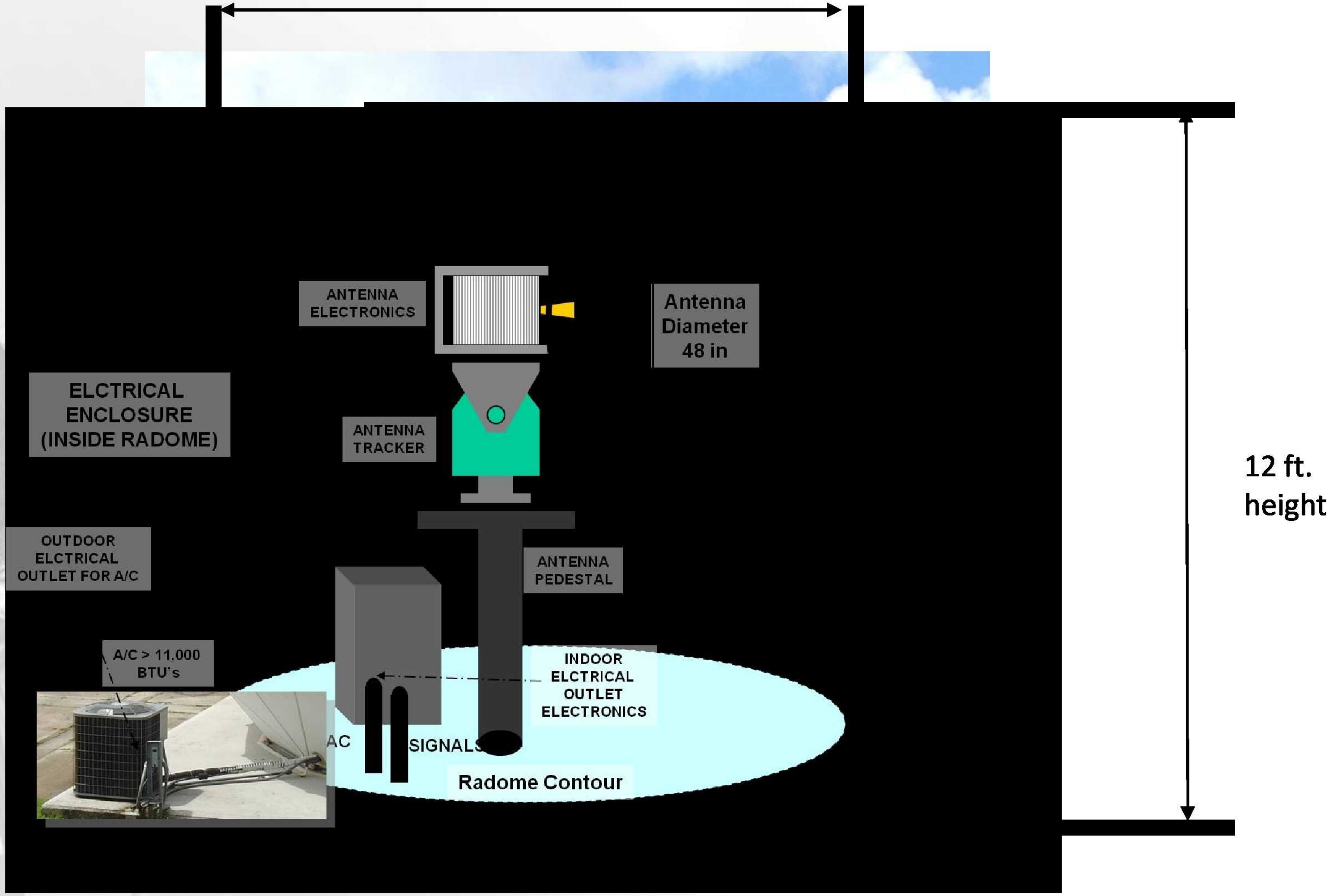
± Monitoring of propagation terminal operation, addressing potential system issues, if necessary

± Provide external access to data (internet connectivity)

KSAT to provide the following infrastructure:



Svalbard Terminal Overview



ROM Proposed Effort

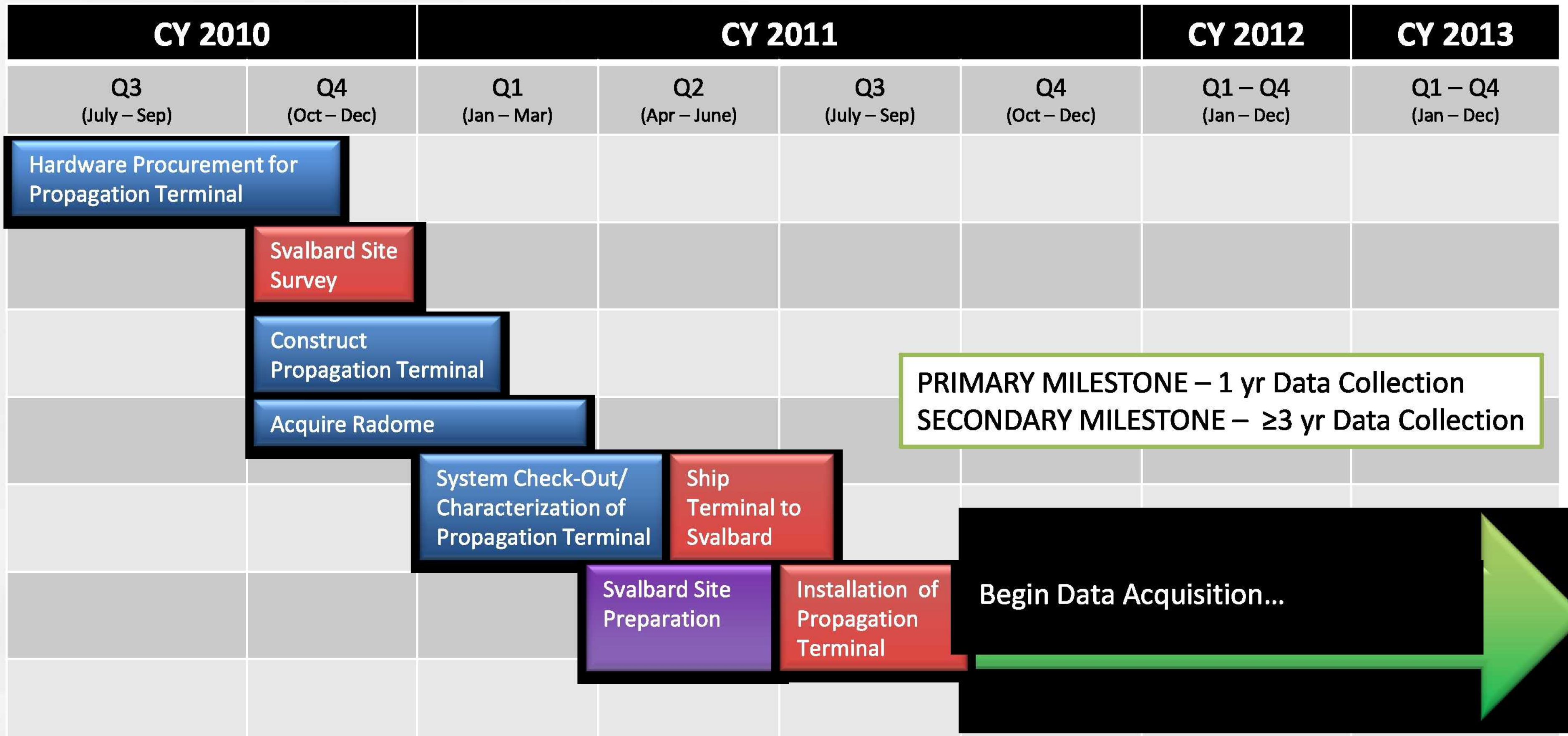
NASA Funding	FY11	FY12	FY13	FY14
RF Propagation Terminal (Beacon Receiver + Radiometer) *	$15K	--	--	--
Propagation Terminal Radome (Galileo Composites) **	$20K	--	--	--
Shipping Costs **	$10K	--	--	--
Contractor Labor (Construction/Operations)	$30K	$20K	$20K	$20K
Travel (estimate $5K/trip/person)	$20K	$10K	$10K	$10K
Total:	**$95K**	**$36K**	**$36K**	**$36K**

KSAT Funding	FY11	FY12	FY13	FY14
Site Preparation **	$75K	--	--	--
Contractor Labor **	$50K	--	--	--
Site Operator Support (0.1 WYE) **	--	$30K	$20K	$20K
Data Access (Internet Services)	--	$2K	$2K	$2K
Total:	**$125K**	**$32K**	**$22K**	**$22K**

* Propagation Terminal cost reduced for FY11 budget due to use of FY10 funding for hardware procurements

** Svalbard costs are best estimates derived from Guam construction costs (may not fully address issues concerned with climate)

Proposed Schedule/Milestones



Note: Schedule derived for Calendar Year (CY)

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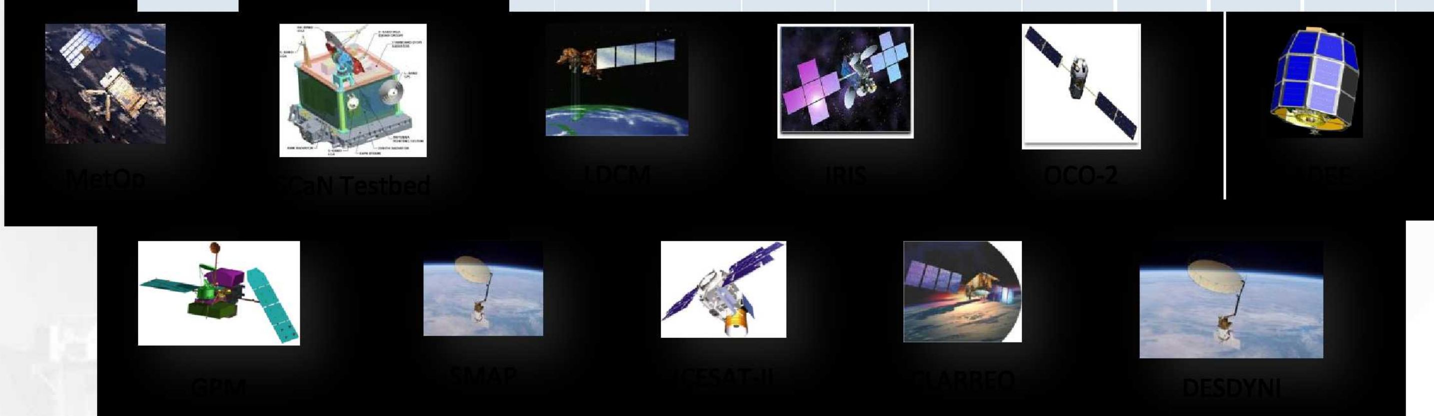
QUESTIONS?

New Mission Drivers Summary
11 Missions Launching in Next 7 Years Require NEN Upgrades

	Mission & Launch Date												SCaN SRD Requirement	Total # of Drivers
	MetOp [1]	SCaN Testbed	LDCM	IRIS	OCO-2	LADEE	GPM-Core	SMAP	ICESat-II	CLARREO-1	DESDynI-Lidar	CLARREO-2		
	FY11		FY13					FY14	FY16	FY17 +				
OQPSK Modulation	X	X	X	X	X		X	X	X	X	X	X	X	12
LDPC Decoding				X					X	X	X	X	X	6
CFDP									X	X	X	X	X	5
SLE									X	X	X	X	X	5
Data Rate >150 Mbps									X	X	X	X	X	5
Other Services	X [2]					X [3]		X [4]						3



Notes:
1) NEN support commences
2) McMurdo X-Band Freq. Expansion
3) Lunar: WS-1 (Multi-Mission)
4) MTRS-2